EXHIBIT D

Forensic Report
May 26, 2022

File: **McCoy vs. GM – 2018 GMC Sierra HD**

Subject: **Vehicle Safety Performance**

Preliminary:

My name is Chris Caruso. I am an engineer working as a consultant in the area of automotive safety. I have been asked to provide my analysis and opinions in this case.

A true and correct copy of my *curriculum vitae* is attached as Exhibit A. As set forth in my *curriculum vitae*, I graduated in 1986 with a Master of Science in Engineering from Arizona State University. Before earning my Master's degree in Engineering (MSE) at ASU, I obtained a Bachelor of Science degree in Electrical Engineering (BSEE) and Mechanical Engineering (BSME) from General Motors Institute in 1984.

I worked as an engineer in training at General Motors Corporation ("GM") in Trenton, New Jersey from 1979 to 1986. From 1986 to 1987, I was employed as a Systems Engineer in the Advanced Vehicle Systems division of Delco Systems Operations (DSO) in Santa Barbara, California. During this time in the Advanced Vehicle Systems division, my work involved the engineering design and development of a variety of vehicle safety systems.

From 1987 to 1989, I served as Delco Electronics Resident Engineer at Breed Automotive Corporation in Boonton, New Jersey. During this time I was involved in the development and implementation of the second generation of airbag systems on GM vehicles and their subsidiaries in the US and overseas and the first generation of ball/tube sensing systems for GM and their worldwide subsidiaries vehicles.

From 1989 to 1995, I worked as the Lead Systems Engineer for Automotive Safety Systems at Delco Electronics Corporation in Kokomo, Indiana. As the Lead Systems Engineer for Automotive Safety Systems at Delco, in addition to other vehicle systems, I supported the development of the techniques and concepts for the first generation Event Data Recorder ("EDR") (which was a part of the electronic module known as Sensing and Diagnostic Module ("SDM")). I was also responsible for investigating sensor issues in crash tests and field performance, including Crash Data Recording/Event Data Recording (CDR/EDR) downloads and interpretations.

During this time I also was a lead engineer in the development of crash sensor specifications and the airbag sensing systems for major OEM's worldwide. This included the development of the "Sensor Mounting Guidelines" specification provided to all OEM's who were implementing Delco Electronics safety systems.

From 1995 to 1999, I worked in the Advanced Algorithm Development Group at Delco Electronics in Kokomo, Indiana. During this time I developed algorithm design and crash sensing techniques for the new Electronic Frontal Sensor ("EFS") for frontal crash detection and also supported the development of the Frontal impact Sensor ("EFS") algorithm and signal processing designs.

I also reviewed and evaluated the methods, procedures and processes for the development of the airbag safety systems. As part of my work I designed the SDM crash sensing algorithms and CDR/EDR crash data recording logic. I also supported the development of the signal processing of input acceleration data for the next generation SDM sensor designs. I also designed a stand-alone CDR for application in field vehicles and fleet vehicles such as taxis and rental cars, as well as conducted detailed analysis of crash test data to determine sensing system design and performance. I investigated and identified sensor issues in crash testing and field performance, including many CDR/EDR downloads and interpretations. My work also included development of systems and sensors and analysis of data relating to vehicle crashworthiness.

In 1999, I also served as Senior Development Engineer for Automotive Safety Systems at Delphi Delco Electronics Systems in the Wuppertal Technical Center in Wuppertal, Germany, where I helped create an automotive safety system development group for our German engineering design center.

From 1999 to 2002, I was the Advanced Product Development Engineer at Delphi Delco Electronics Systems in Kokomo, Indiana. In addition to other projects, during this time I developed the next generation of front and frontal impact airbag sensing systems, as well as other vehicle safety systems and technologies, including crash sensing and system development for rollover roof rail airbag systems. I also obtained patent protection for six (6) crash sensing algorithms in connection with frontal and side airbag systems. I also continued to be involved in field investigations related to problems observed in system performance, including EDR/CDR downloads and interpretations. During this time, I evaluated potential airbag system defects and developed corrective actions and solutions to remedy problems that were found.

From 2002 to 2003, I worked as the Engineering Group Manager at Delphi Delco Electronics' Mexico Technical Center in Juarez, Mexico. During this time, I

managed engineering teams that developed software, systems and test engineering for Passive Occupant Detection System (PODS-B) and SDM and Satellite Sensor projects and continued my work involving vehicle systems product performance anomalies and issues, including substantial work involving downloads and interpretations.

In 2003, I was promoted to Technical Manager for Automotive Safety Systems at Delphi Corporation and continued in this role through 2006. During this time, I served as the Expert Technical Lead of all engineering disciplines (Systems, Mechanical, Electrical, Software, Test) on the development and product engineering of the PODS-B for advanced airbag systems. I also initiated the Advanced Development Project for revisions to the existing PODS-B algorithm and electronic technology. I regularly investigated and analyzed issues with the PODS and SDM systems in vehicles in the field and observed during developmental testing. In addition, a substantial part of my work involved CDR/EDR downloads and interpretations. I also provided regular training and classes in Airbag Systems and Occupant Detection Systems to engineers at Delphi and customer teams. I led the technical design review for Electronic Control Units (ECUs) and supported continuing development of the SDM and other airbag related technologies.

I voluntarily left Delphi in August of 2006. In July of 2007, I founded Automotive Safety Consulting, which provides automotive safety and technology consulting. The focus of my work with Automotive Safety Consulting involves: (1) analysis of passenger vehicle crashes and determination of the performance of the applicable safety systems; (2) identification and analysis of defects or deficiencies in occupant protection systems, if applicable; (3) research and analysis of the feasibilities and capabilities of safety system technologies and measures for preventing injuries and fatalities in a variety of field crash conditions; (4) development of protocols and support for CDR/EDR downloads; and (5) interpretation and analysis of CDR/EDR downloads.

As referenced in my CV, I have obtained six (6) patents in automotive safety technologies, 3 of which directly relate to crush zone crash sensing and all 6 of which are for products that are used in production vehicle safety systems. My work has also included two (2) publications and presentations for the Society of Automotive Engineers (SAE) International Congress involving automotive safety systems.

During the course of my work involving automotive safety systems, including my work involving SDM and Satellite crash sensing systems and analysis, I have received several awards and honors. For example, I am a recipient of the: (a) Delco Electronics Boss Kettering Award for Engineering Excellence; (b) the GM President's Council Honors Award for Engineering Excellence; (c) the Delphi Lead

Award for Advanced Engineering; (d) the GM People Make Quality Happen Award for Design Engineering Excellence; and (e) the Delphi Corporation Boron Recovery Award for Problem Solving, as well as numerous other awards and recognitions from GM, Delphi, and other OEMs.

In addition to safety consulting for various organizations needing technical information and guidance, I also provide consulting for parties in products liability cases involving automotive safety systems. I have served as a consultant for both plaintiffs and defendants in numerous cases involving automotive safety systems, including cases involving EDR/CDR downloads and readouts.

As set forth above, over the course of my years as an engineer and as a result of my background, education, training, and experience, which includes over 36 years of experience working with vehicle safety systems and over 43 years working in the automotive engineering field, I have obtained extensive knowledge regarding airbag safety technologies for frontal impact, frontal impact, rollover, rear impact occupant protection systems and devices, as well as occupant classification systems.

Background

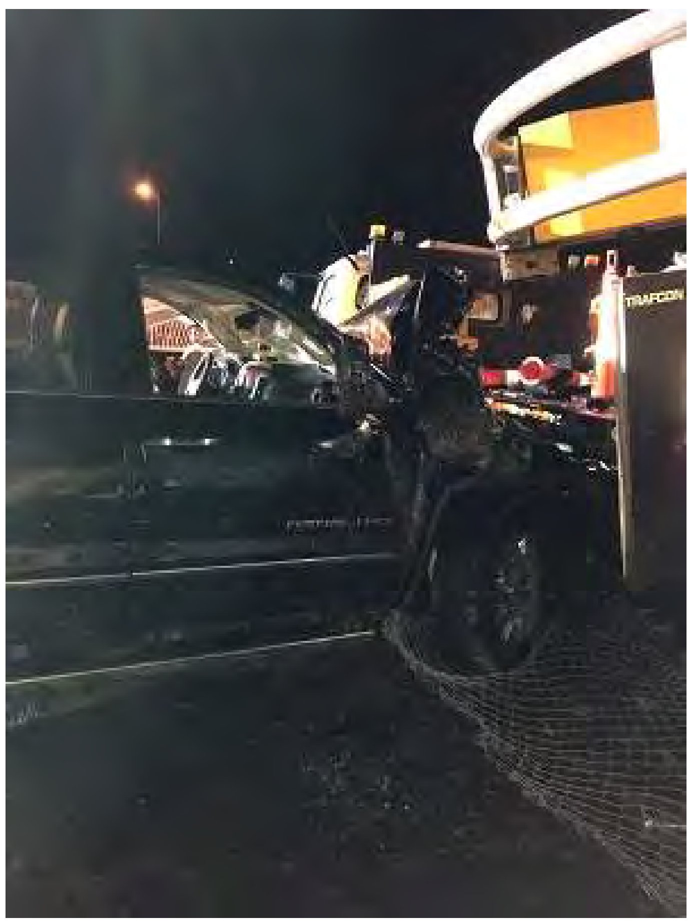
This report addresses an incident that occurred on October 17, 2019 when Mark McCoy, driving a 2018 GMC Sierra HD ran off the left side of the roadway on an exit remap from Interstate 84, collided with two vehicles and a fence at a construction staging yard, causing significant frontal damage to the truck. The frontal impact airbag did not deploy. Mr. McCoy was seriously injured in the collision.

The scene photo below shows the truck having gone through the fence and sitting atop the flatbed trailer up against the construction truck.

2018 GMC Sierra HD – Scene Photo

The following 2 scene photos shows the vehicle up against the axle of the construction truck.

2018 GMC Sierra HD – Scene Photo



2018 GMC Sierra HD – Scene Photo

This photo is of the post-accident subject 2018 GMC Sierra HD vehicle. Clearly there is a moderate to severe frontal impact to the front of the vehicle, which would warrant the deployment of the driver frontal impact airbag. The failure to deploy the airbag resulted in a vehicle that was defective, unsafe and unreasonably dangerous and led directly to the injuries suffered by Mr. McCoy.

2018 GMC Sierra HD – Inspection Photo

Material Reviewed:

- Connecticut Uniform Police Crash Report
- Scene Photos
- Danbury Hospital Records
- CDR Download from the Subject Vehicle
- ESIS Documents
- Inspection photos of the subject vehicle
- 2018 GMC Sierra 2500HD – Mitchell CRS Summary
- 2018 GMC Sierra 2500HD – NHTSA Ratings
- 2018 GMC Sierra 2500HD – NHTSA Recall Database
- 2018 GMC Sierra 1500 – IIHS Ratings

- GM and Aptiv (formerly Delphi) Document Production
- Exemplar Photographs

<u>Examination</u>:

This subject collision was a partial underride impact to the front of the subject 2018 GMC Sierra HD. Although less common for a heavy duty truck than a car, underride impacts are still foreseeable real world crash events where one vehicle rides underneath the structure of another vehicle, resulting in the primary deformation being above the bumper beam and primary vehicle structures. This results in a longer, softer crash onset, but once the upper sheet metal (grill, radiator, headlamps, etc.) deform rearward to the engine, the crash pulse can become quite severe.

In our case, the subject collision still had a significant impact into the bumper and rails from the engagement with the construction truck axle, but clearly there was an underride component since the top of the radiator is clearly pushed further rearward than the lower radiator support and bumper structures.

2018 GMC Sierra HD – Inspection Photo

Based on the documents provided by both GM and Aptiv (crash sensing system supplier), GM had a 20mph Bumper Under-ride MUST DEPLOY Barrier test requirement for the subject vehicle, however, that was never directly tested, it appears that was evaluated based on some type of computer simulated crash data:

15-K2HD-FE01.01.

Frontal Sensing Calibration Thresholds

Threshold establishment method: Barrier Test and Supplier Scaling predictions

Threshold Condition	Speed km/h (mph)	Nominal Deployment Time [ms]		Test #
		Retractor Pretensioner Driver/Pass	Front Airbag Driver/Pass	
0 Degree Frontal Thresholds				
No Deploy	14 (9)	ND	ND	C18329
All-Deploy	22 (14)	32	32	C19078
30 Degree Angle Frontal Thresholds				
All-deploy	28 (18)	33	33	15-K2HD-FE01.04 (Left)
		33	33	15-K2HD-FE01.05 (Right)
Other Frontal Sensing Conditions				
Offset Deformable Barrier	40km/h (25mph)	27	27	C18437
0 Deg Center Pole	35km/h (22mph)	46	46	15-K2HD-FE01.02
Bumper Under-ride Barrier	32km/h (20mph)	38	39	15-K2HD-FE01.01

2018 GMC Sierra HD – Calibration Thresholds

In this 20mph underride crash, the frontal impact airbags must deploy by 50ms to provide adequate occupant protection, according to the separately supplied calibration summary. In the subject crash, the estimated Delta V is approximately 30-35mph with an initial estimate of between 120-150ms time duration. This clearly is above both the standard airbag deployment threshold of 16mph rigid barrier impact as well as the 20mph underride severity. GM would have expected the frontal impact airbag, possibly a Stage 1 plus Stage 2 inflation level.

The failure to deploy the driver frontal impact in the subject collision left Mr. McCoy without any of the supplemental protection GM included in the vehicle safety system. Again, the failure to deploy this airbag was defective, unsafe and unreasonably dangerous.

The dual front EFS sensors are located on the underside of the lower radiator support of the 2018 GMC Sierra HD.

Mitchell RepairCenter™ TechAdvisor

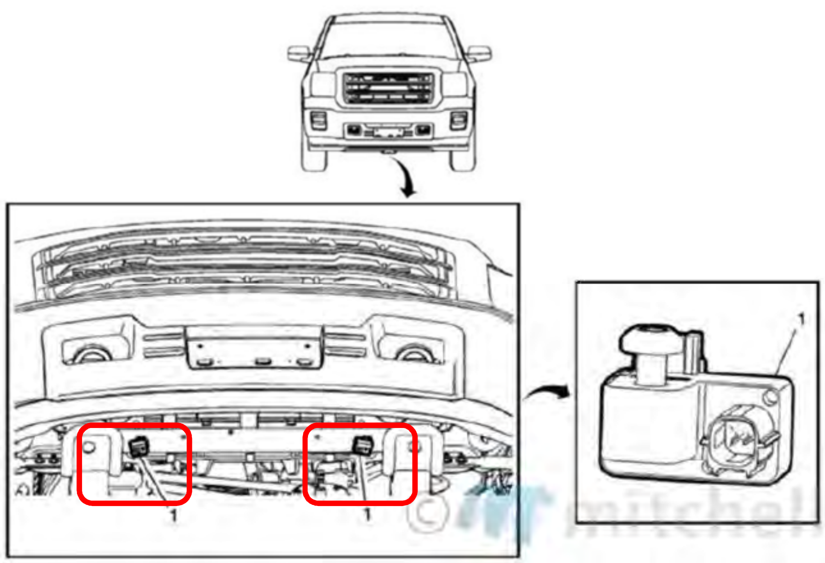
2018 GMC 2500HD Sierra Denali

Restraint Systems / Air Bag Service & Repair / Airbag / SUPPLEMENTAL INFLATABLE RESTRAINTS

Frontal Impact Sensing and Deployment (2500/3500)

Front End Inflatable Restraint Discriminating Sensor Replacement

Fig. 20: Airbag Front End Discriminating Sensor



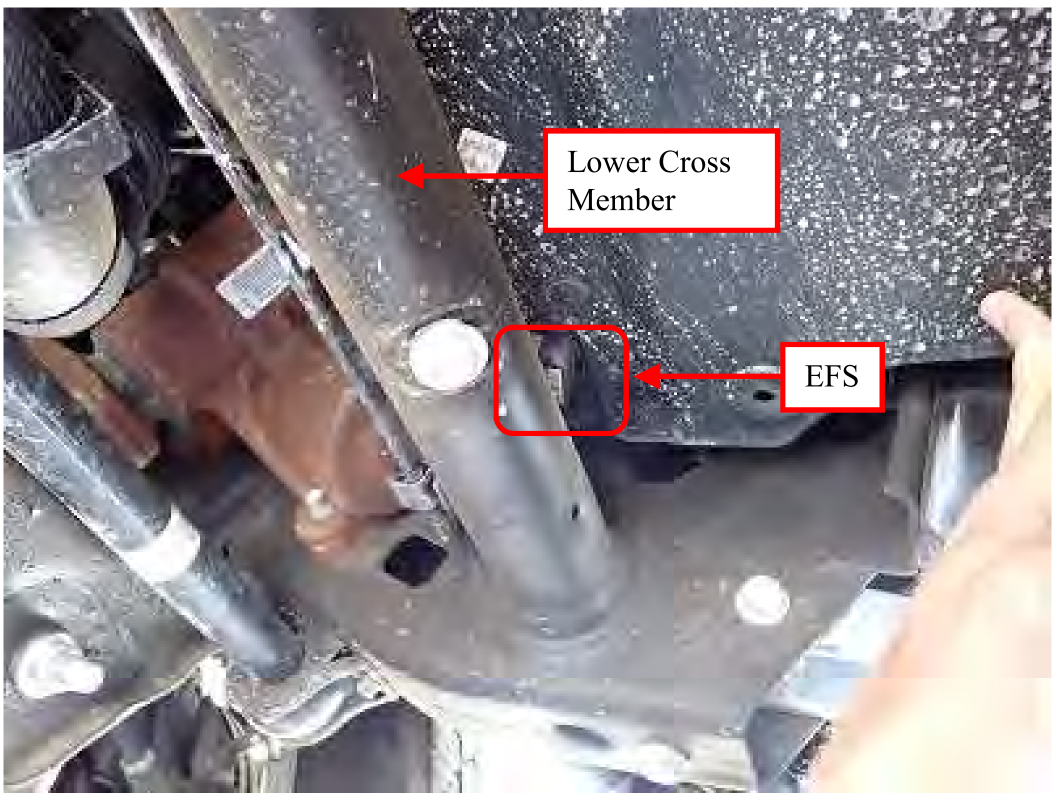
2018 GMC Sierra HD – Mitchell Repair Center Details

During my inspection, I noted that the EFS sensors and the entire lower radiator support were rotated rearward and upward at some point in the collision sequence.

2018 GMC Sierra HD – Inspection Photo – EFS Rotated Upward

This rotation, if it occurred early in the construction truck crash or during the trailer undercarriage impact, this would have taken the EFS sensor out of the primary frontal impact direction (they have a single axis accelerometer inside that needs to be looking forward) and with them pointed upward in the vertical direction they would no longer be seeing the fore/aft crash severity and would fail to determine that airbag deployment was necessary.

However, subsequent inspection of an exemplar by Nick Earnhart showed that these sensors were well protected by the lower frame cross member and would have been unlikely to have been impacted and rotated during the trailer impact. Thus, although this was an initial concern, the information available would make this a low probability failure mode. It cannot be ruled out, but would likely have happened late enough in the crash that the airbag should have already deployed.



2018 GMC Sierra HD Exemplar – Earnhart Inspection Photo –
EFS and Cross Member

The next key piece of forensic evidence was the fact that the Sensing and Diagnostic Module (SDM) in the subject vehicle failed to record ANY crash event.

There were 3 events in the sequence: A chain link fence, a low boy trailer and the construction truck. According to GMs own specifications, even if no airbag deployment occurs, any event greater than 8km/h (5mph) will be recorded as part of the Crash Data Recording (CDR). From the excerpt below, it is clear than no event was recorded for this subject collision even though the event was clearly above 5mph.

BOSCH

CDR CRASH DATA RETRIEVAL

IMPORTANT NOTICE: Robert Bosch LLC and the manufacturers whose vehicles are accessible using the CDR System urge end users to use the latest production release of the Crash Data Retrieval system software when viewing, printing or exporting any retrieved data from within the CDR program. Using the latest version of the CDR software is the best way to ensure that retrieved data has been translated using the most current information provided by the manufacturers of the vehicles supported by this product.

CDR File Information

User Entered VIN	
User	R. Yeager
Case Number	MCCOY
EDR Data Imaging Date	08/13/2020
Crash Date	10/17/2019
Filename	ESIS AIRBAG DATA (CDR) - MCCOY ( ).CDRX
Saved on	Thursday, August 13 2020 at 11:14:12
Imaged with CDR version	Crash Data Retrieval Tool 19.4.2
Imaged with Software Licensed to (Company Name)	ESIS - General Motors
Reported with CDR version	Crash Data Retrieval Tool 19.4.2
Reported with Software Licensed to (Company Name)	ESIS - General Motors
EDR Device Type	Airbag Control Module
Event(s) recovered	NONE

2018 GMC Sierra HD – Crash Data Recording

The failure to record any data in this collision, also clearly violates GM's own specifications for the safety system. This can generally occur in one of three ways:

1. The event does not exceed 5mph
2. The SDM was without power at the time of the collision
3. The vehicle power system was interrupted during the crash.

In the first case, we know this event was clearly above the CDR recording threshold, therefore, this would not have been a factor.

In the second case, this is more difficult to prove and also the most difficult to eliminate. The fact that we had an above threshold frontal impact but the frontal impact airbag did not deploy and the fact that we had no crash data recorded identifies this as a possible root cause of BOTH failures. The GM Ignition switch defect and subsequent recall had these types of failures, however, it was not clear if this 2018 model vehicle would have had similar issues to the known defective GM ignition switch.

The third item is common in collisions such as this. Late in the crash event, the vehicle battery and fuse block can enter the crush zone and be destroyed. My inspection of the subject vehicle shows that this was likely. However, with the SDM having an energy reserve, this would not have prevented the airbag deployment, even if it failed to complete crash recording.

Thus, if we look at the key factors here, we had a deployment level crash event but no recorded data. With this, both items 2 and 3 are feasible scenarios, but if we focus on the lack of deployment, it leaves us with 2 possibilities to consider. If the failure to deploy was because of item 2, the complete power loss BEFORE the crash, then the root cause was simply this loss of power. But we need to determine the root cause of that catastrophic power loss. If the failure to deploy was part of item 3, then we must look at the crash sensing system to determine the root cause of the failure to recognize this crash as a severe event where airbag deployment was necessary. We will focus on this next.

First let's cover the loss of power. In the SDM, there exist an energy reserve capability. What this means is that since we know loss of vehicle power is common in crash events, particularly moderate to high severity crashes will significant intrusion into the engine bay, we provide internal capacitors within the SDM to provide a limited amount of additional power so that we can continue to process the crash information, deploy airbags and pretensioners, if needed, and then to perform the crash recording function.

From the SDM30 specification (the model that was used in the subject vehicle, it was shown that the energy reserve capability varied by function. The table below shows the energy reserve minimum requirement for the various SDM functions for the reserve power, which includes deployment of airbags, providing power to external satellite sensors, crash notification services and the disposal of any non-deployed stage 2 airbag inflators:

GM	ENGINEERING STANDARDS	Component Technical Specification	SDM30 / ESS (Global-A)

3.4.6 Energy Reserve

Table 7 provides a summary of energy reserve times for SDM functions.

Function	**Minimum Energy Reserve Time**
Satellite Sensors (ESS)	100 ms
All Deployment Loops (6 / 12 / 18 / 20 loops)	100 ms
Airbag Disposal function (for 2nd or 3rd stage)	150 ms
Automatic Crash Notification (GMLAN communication)	200 ms
Event Data Recording (EDR)	300 ms

GM Technical Specification Excerpt – SDM30

With the advent of NHTSA regulated Event Data Recording regulations in 2006, a 300ms for energy reserve is a very low number. Particularly with concatenated events and multiple rollover events, the duration of the entire crash sequence can take several seconds, and this low energy reserve value is likely to lead to failed EDR/CDR data under some foreseeable, real world crashes.

Assuming the vehicle power is lost during the 33mph impact into the construction truck, 300ms of Event Data Recording backup power should have been sufficient to complete most, if not all of the CDR data writing. Since we know the SDM30 did not record any event, then we must assume that some other factor played into the loss of power, before the system could complete writing the CDR data.

One such event could have been loss of power during the flatbed trailer impact. Interruption of battery power or an ignition key being jolted from the RUN position into the ACCessory position during this undercarriage strike. Although not common, it cannot be ruled out, as we try to understand the missing data from the SDM in a crash event clearly above the minimum 5mph requirement to dictate the writing of a crash event to memory.

Based on reconstruction estimates, if the battery or ignition feed were lost during the flatbed trailer impact, we have 200ms from onset of this event to the onset of the 120-150ms long construction truck event. Thus, based on the above table, depending on when the loss occurred, we would lose energy reserve to satellite sensors after 100ms as well as the ability to deploy airbags and pretensioners.

Thus, a catastrophic loss of power at least 100ms before the construction truck impact would prevent any deployments. A loss of power 300ms before the end of the construction truck crash would prevent both deployment as well as crash recording. There is no means available that I can envision where we could verify

the loss of power prior to or during the impact. But this could certainly be an explanation of the failure in itself.

Next we will focus on the crash sensing aspect of the possible defect. The 2018 GMC Sierra HD crash sensing system consists of the dual FCS sensors discussed above coupled with the SDM's own internal crash sensing capabilities. The crash sensing algorithm takes data from all 3 sensor locations and through a series of calculations and threshold comparisons makes severity level assessments and initiates the deployment of any necessary safety systems.

In this case, APTIV, the SDM and EFS supplier, utilizes a complex set of algorithms and rules. The Algo-Front5 system consists of dual 50G 45 degree oriented accelerometers within the SDM and 500G accelerometers in the EFS crush zone sensors. The EFS sensors send filtered acceleration data to the SDM. The SDM processes all the signals internally. Each of the devices is capable of providing both crash discrimination (Deploy and No Deploy) as well as "Safing" for the system. Safing is a safety check to insure that a deployment command is supported by at least one other sensor in the system, so that a single point sensor failure will not result in an inadvertent deployment.

The system can provide 5 levels of frontal crash severity output. The five levels, in order of crash severity are:

1. Seatbelt Pretensioner ONLY
2. Unbelted Occupant Stage 1 Airbag Deployment
3. Belted Occupant Stage 1 Airbag Deployment
4. Unbelted Occupant Stage 2 Airbag Deployment
5. Belted Occupant Stage 2 Airbag Deployment

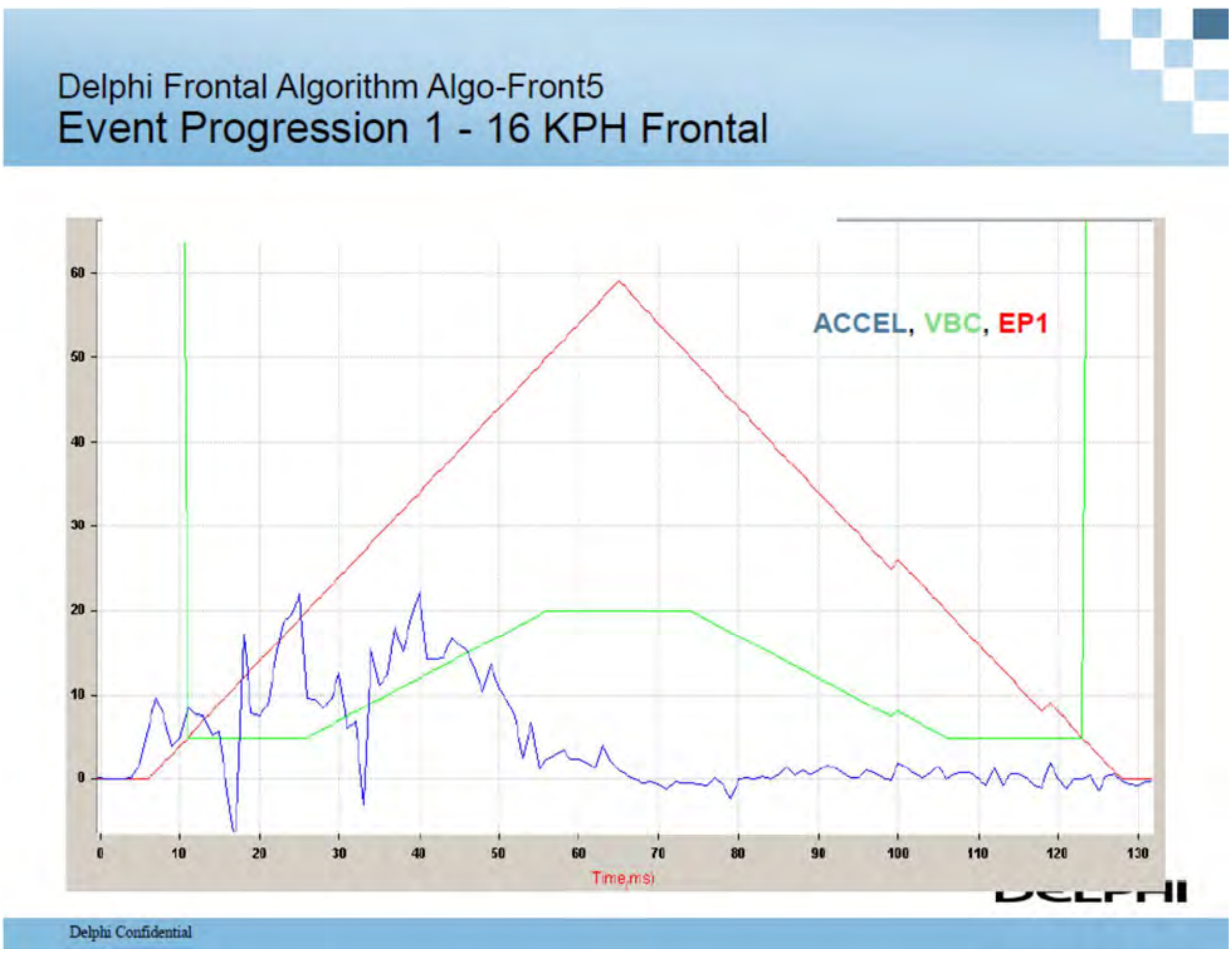
Thus far, the SDM and crash sensing conditions are typical of the industry standards for 2018. The system is also capable of rear impact and rollover safety, but this will not be discussed here as these are not relevant to this subject collision.

Each EFS and the SDM are capable of system "Wakeup" when any of these devices experiences an acceleration value above the wakeup or "enable" threshold. However, one concern I identified with the system is that ALL sensors must RESET before the system will reset. Thus, if any of the sensors is still awake, the entire system remains awake. This could lead to a concatenated event issue, depending on how the SDM calculations are being performed.

A concatenated event is one where multiple events happen in series, as with the subject event. Recall in our collision, we have a fence impact, followed by a

trailer impact, followed by the construction truck impact. It is imperative that the system properly parse these into 3 discrete events. By requiring all 3 sensors to reach a reset condition could lead to the overall algorithm failing to parse this into 3 separate events, thus, considering this one long event, and possibly making incorrect decisions on event severity.

Reviewing the primary part of the SDM algorithm, it is carry over from the years I was designing these systems at Delphi. Without getting into the complexities the following graph from the algorithm presentation document shows that, depending the calibration, the concatenated even performance should be reasonable for most multiple event scenarios. This chart shows that once the primary event is over, it takes time for the system to reset. During this time, the threshold is still active and if another event should occur (concatenated event) the system can process the new event and still have active thresholds, even if it does not completely reset. EP1 is the crash "clock" and you can see the red curve below increments up to about 58ms and then slowly decrements back to zero. The green deployment threshold also moves back to its original position. If you look close, the tail of the green curve is a mirror image of the beginning of the curve. This is the way the system is supposed to work.

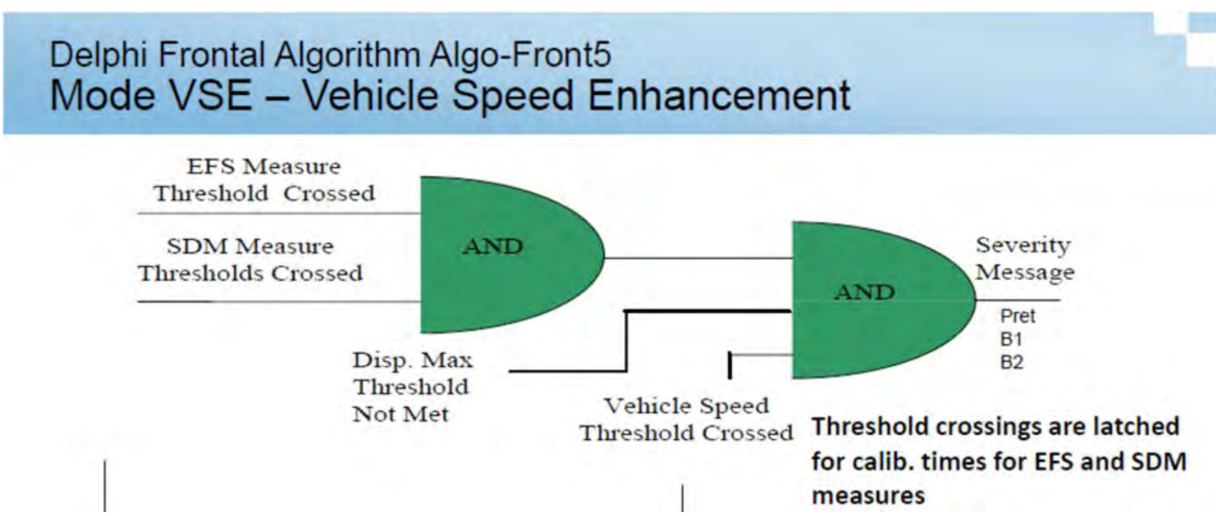


Crash Algorithm Presentation Excerpt – Threshold Performance Over Time

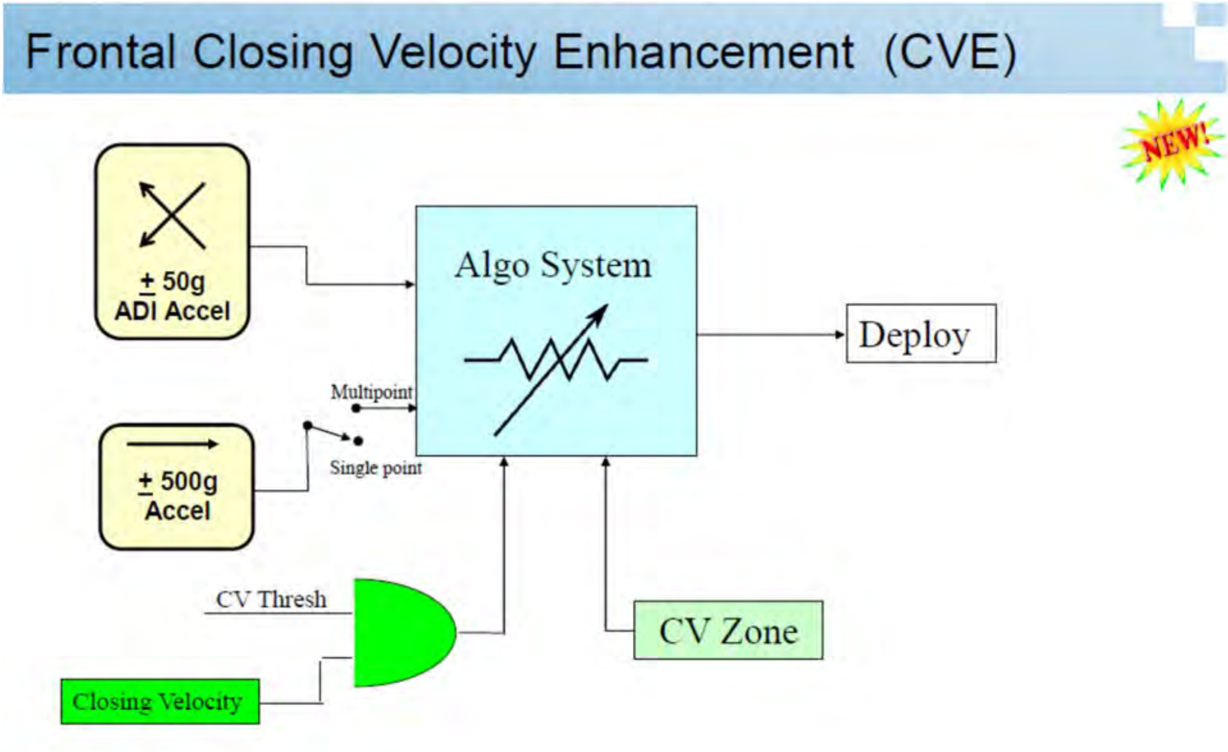
However, Aptiv added a new series of criteria to the algorithm. The first of which are the VSE and CVE modes. The VSE mode uses vehicle speed at time of wakeup to compare to different sets of deployment thresholds. In theory, if we know the vehicle speed at the onset of the collision, we can make an 'educated guess' at the potential severity, and thereby, use lower thresholds for faster deployment times.

Similarly, the CVE mode uses closing velocity at time of wakeup as a means of optimizing threshold crossings. On the surface, I have no issues with these criteria, however, what concerns me is that with these criteria active, other parts of the system calibration may be compromised on the assumption that the overall system is getting its timely deployment from this VSE mode.

But what if the vehicle speed at wakeup does not properly represent the oncoming crash severity (head on collision – subject vehicle at 50mph, opposing vehicle at 50mph; 100mph impact speed vs 50mph vehicle speed)? What if the closing velocity at wakeup does not represent the oncoming crash severity (50mph Deer Impact, with no need for airbag deployment in most cases)? Will the rest of the algorithm be able to properly determine crash severity? Is the entire calibration providing good redundancy, should any of the firing "Modes" fail to detect the appropriate crash severity?



Crash Algorithm Presentation Excerpt – VSE Enhancing



Crash Algorithm Presentation Excerpt – CVE Enhancing

It is not clear without having crash data from the CDR to assess if either of these enhancements could have influenced the overall algorithms ability to discriminate this subject collision scenario, which was never tested in a laboratory. However, using potentially erroneous external values for closing velocity and vehicle speed prior to impact, could adversely impact the normal functionality of the crash sensing algorithm.

However, the most important thing I noted in the calibration and algorithm reviews was that although I had believed GMTG was no longer forcing the use of 45ms shutoff times in 2018 model year with the SDM30, they appeared to be using very similar shutoff times in this calibration. Looking at the production parameter files, we are looking for the calibration name that ends with "ep_end_threshold". My recollection, although I was not able to confirm it, is that the crash sensing algorithm uses a 1.25ms time step. The calibration values are in "counts". Thus, a 45ms STOP time would equate to 45/1.25 = 36 counts in the calibration. Reviewing the detailed calibration file (Bates ASUS 011933- 011963) I found this range of values for this parameter:

12 counts x 1.25ms/count = 16ms

40 counts x 1.25ms/count = 50ms

Thus, it appears that GMTG is still employing very aggressive stop times. Since our subject crash had 2 key consecutive events (impact with the flatbed trailer followed by impact with construction truck) with an estimated total time duration of about 200ms from the initial impact with the trailer to the initial impact with the construction truck, these aggressive calibration "ep_end_threshold" or SHUTOFF times, could have enhanced the algorithms inability to handle the concatenation of these two events, and the deployment threshold were SHUTOFF at the time the 33mph construction truck impact occurred.

a5_cal2_.mode0_1_.ep_end_threshold	16
a5_cal2_.mode0_1_.threshold_step	20
a5_cal2_.mode0_1_.threshold	110
a5_cal2_.mode0_2_.ep_begin_threshold	11
a5_cal2_.mode0_2_.ep_begin_slope	14
a5_cal2_.mode0_2_.ep_end_slope	15
a5_cal2_.mode0_2_.ep_end_threshold	16
a5_cal2_.mode0_2_.threshold_step	20
a5_cal2_.mode0_2_.threshold	110
a5_cal2_.mode0_3_.ep_begin_threshold	27
a5_cal2_.mode0_3_.ep_begin_slope	27
a5_cal2_.mode0_3_.ep_end_slope	32
a5_cal2_.mode0_3_.ep_end_threshold	32
a5_cal2_.mode0_3_.threshold_step	0
a5_cal2_.mode0_3_.threshold	99999
a5_cal2_.mode0_4_.ep_begin_threshold	27
a5_cal2_.mode0_4_.ep_begin_slope	27
a5_cal2_.mode0_4_.ep_end_slope	32
a5_cal2_.mode0_4_.ep_end_threshold	32
a5_cal2_.mode0_4_.threshold_step	0
a5_cal2_.mode0_4_.threshold	99999
a5_cal2_.mode1_0_.ep_begin_threshold	13
a5_cal2_.mode1_0_.ep_begin_slope	13
a5_cal2_.mode1_0_.ep_end_slope	18
a5_cal2_.mode1_0_.ep_end_threshold	36

X2HD Truck Calibration Excerpts – EP_END_THRESHOLD examples

With earlier model GMTG truck and SUV vehicles, I have had numerous failure to deploy cases where the root cause was determined to be the 45ms SHUTOFF criteria. I this case, the shutoff time varies based on the deployment mode of the algorithm but as stated above, they range from 16ms to 50ms. If the crash sensing algorithm is unable to reset during this gap between the onset of the trailer impact and the onset of the construction truck impact, the shutoff times will prevent the algorithm from deploying when the 33mph construction truck impact occurs.

The principles identified in their crash sensing algorithm and calibration strategy, including 'safing' are consistent with other systems that I have designed

and evaluated. However, although the design appears logical, the fact that the driver frontal impact airbag fails to deploy in a crash that is well above the airbag deployment threshold established by GMTG, clearly shows the GMTG implementation on the subject 2018 GMC Sierra HD is defective, unsafe and unreasonably dangerous.

The following would be alternative designs that existed in 2018 Model Year that GM could have employed in the 2018 GMC Sierra HD Frontal impact Safety System:

1. Modify the algorithm calibrations with more robust 120-150ms ep_end_threshold values.
2. Provide a larger energy reserve capability than 300ms, to insure that not only can airbags be deployed, but that crash recording can be completed.

Ultimately, the defective design and calibration of the frontal impact crash sensing system resulted in the failure to deploy the impacted driver frontal impact airbag in the subject crash. This condition was defective, unsafe and unreasonably dangerous to the vehicle occupants Mr. McCoy

<u>Opinions</u>:

Based on the review of all the available information, a detailed review of the photos, available technical information, alternative designs and based on my years of experience designing, developing crash sensors and occupant safety systems, it is possible to formulate the following conclusions and opinions regarding the performance of the frontal impact airbag system in the subject 2018 GMC Sierra HD. I have formed these opinions utilizing the methodology which is accepted in the automotive safety system design and performance evaluation segments of the occupant restraint system industry.

The opinions rendered in this report are based on my knowledge, education, training, and experience, and are stated to a reasonable degree of engineering and scientific certainty. These opinions are based upon my review and analysis of the materials available as of the date of this report. I reserve the right to supplement or change the opinions expressed in this preliminary report based upon review of new materials or additional pertinent information, analyses or documentation received in the future:

- The vehicle crush conditions and severity of the subject collision were such

that the Driver Frontal Impact Airbag in the 2018 GMC Sierra HD should have deployed. This failure to deploy this airbags resulted in a condition that was defective, unsafe and unreasonably dangerous to the driver in this vehicle.

- Safer alternative designs existed, as set forth in the body of this report and they consisted of properly calibrated frontal impact crash sensors for the frontal impact restraint system that could have been employed in the 2018 GMC Sierra HD at the time that the vehicle left the control of General Motors Corporation. The failure to use a robust calibration resulted in system that was defective, unsafe and unreasonably dangerous to the occupant in this vehicle.

- The safer alternative designs would not have impaired the utility of the occupant restraint system in other testing or real world conditions if properly developed and employed in the 2018 GMC Sierra HD.

- The safer designs were both economically and technologically feasible at the time that the occupant restraint system left the control of General Motors Corporation.

- There were no known material alterations to the occupant restraint system and the subject vehicle after it left possession of the manufacturer which would have affected the performance of the system.

These opinions are based on all data which was available at the time of this report. Additional data provided as a result of detailed document discovery and production, at a later date could result in a refinement in the opinions and conclusions generated in this document. I also reserve the right to make additional observations and opinions and/or to modify observations and opinions based upon the review of the opinions of other experts.

Chris Caruso

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(CV Provided Upon Request)